Status and Monitoring of Ambient Air Quality of 'Cityof Lakes' Udaipur, (Raj.) India

Ambient Air Quality of Udaipur City

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Abstract

Air pollution has been identified as a serious problem throughout the world which causes tremendous loss to human health and the crops by affecting plant growth and yield. Earlier, air pollution was restricted to urban and industrial regions. But it has become evident that pollutants can be transported over long distances and hence their impact may be felt widely over rural and forest areas. To study effect of automobile on plant growth and other types of pollution, comparative basis mean concentrations of SO_2, NO_2, SPM and RSPM were determined in sampling areas, viz., urban, industrial and forest areas of Udaipur, which is a typical tropical city but has varied lakes around its peripheral areas and good forest cover that makes it a special site for study of ambient air pollution.

Keywords

Ambient Air Quality; Pollutants; Automobile Pollution; Green Belt; Roadside Pollution

Introduction

In India after industrial revolution followed by urbanization, all kinds of pollution marked its presence in the natural air, water, as well as, in soil causing irreparable damage to the environment. Various kinds of pollutants such as gases, particulate matter, agricultural chemicals, radioactive materials in the atmosphere, oil spills and solid wastes on the land affect the microorganisms, plants , animals and human beings directly or indirectly. According to study of WHO, India's top ten cities are most polluted in the world and the waste generated through human activities is much more than that the system could absorb or assimilate. This has resulted in the problem of pollution (Agrawal and Agrawal,1990; Joshi et al.,1991; Banerjee et al.,1998). A recent study by the Centre for Science & Environment (CSE) has revealed that air pollution has killed nearly 52,000 people in 36 Indian cities every year pre-maturely while hospitalizing about 26 millions (Pattnaik and Pattnaik, 2000). SO_2 pollution studies prove that a wide variety of plants is sensitive to it hence, SO_2 can be used as biochemical indicator of atmospheric pollutant (Aihara et al., 1996 and Beckett et al., 1998). Metal ions in air-borne particulate matters in industrial area and in the process undergo morphological, physiological and biochemical changes (Burchett et al., 2002). Accumulation of higher levels of sulphur in leaves indicates its foliar uptake from polluted atmosphere. A positive quantitative correlation between atmospheric SO_2 and foliar sulphur supports above fact (Li et al., 2001). Kantarci (2003) studied effects of air pollutants on forests in Turkey. Aftab and Sakil (2003) studied sulphur accumulation in plant foliage due to coal smoke pollution. Mahendra and Krishnamurthy (2003) assessed the air pollution concentration from road traffic in Bangalore.

Mehta (2002) studied the impact zone for ambient air quality around SIEL chemical complex by selecting five ambient air monitoring stations in this area. A 210 MW capacity power plant burning "G" grade coal emits about 50-80 tonnes of fly ash per day which adds to 85 million tonnes of fly ash per annum (Banerjee and Sett, 2007). Dwivedi and Tripathi (2007) studied pollution tolerance and distribution pattern of plants in and around coal-fired industries.

Materials and Methods

The city of lakes Udaipur is situated about 600 m above the sea level and is located among the lush green hills of Aravali range between 24°35' N latitude and 73°42' E longitude. There are many lakes around Udaipur and within, e.g., Pichhola, Fateh Sagar and Swaroop Sagar which are deeply involved in social, cultural and economic activities of the city. Ambient air quality monitoring in different localities of Udaipur city has been investigated for two years, i.e., from September, 2010 to August, 2012 on monthly basis. For ambient air quality, different parameters such as SO_2,

NO_x, SPM, CO were selected and the study was conducted at Rajpura Dariba mines, Hindustan Zinc Smelter, Debari, Madri Industrial Area and Sukher (marble processing Industrial area) of the Udaipur district of Rajasthan. Into these areas 10 sites with a difference of 10 meters were ascertained and observations taken indicated mean value of all these sites on the basis of minimum three recording in a day at different times, i.e., morning, noon and evening hours. The leaves of the samples were brought in polythene bags to the laboratory and activity of enzymes was studied immediately. For further analysis these were preserved at 4±0.5°C till analyzed for different parameters within 24 hours of their harvesting. The concentration of SO_2 was measured by Modified West and Gaeke (1956) and NOx was measured by the modified method Jacob and Hochheiser (1985). The SPM concentration was measured using filter paper method (Rehme KA et al. 1984). Carbon monoxide has been analysed by using carbon monoxide analyser. This technique is mainly based upon non dispersive infra red (NIDR) spectroscopy. Measuring for the monitoring purpose is 0.1–10 ppm.

Results

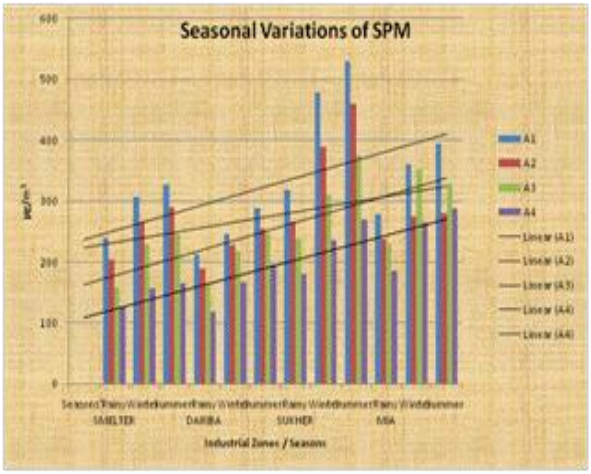
The results of the study have shown 8-hourly mean concentration of suspended particulate matter ranging between 118.39 μg/m³ (Zone-2, Station 4; rainy season) to 528.56 μg/m³ (Zone-3, core area; summer season), sulphur dioxide ranging between 6.29 μg/m³ (Zone-3, station-4; rainy season) to 68.27 μg/m³ (Zone-1, core area; winter season), nitrogen dioxide between 4.33 μg/m³ (Zone-2, Station-4; rainy season) to 42.09 μg/m³ (Zone-4, core area; winter season) and of carbon monoxide between 304.62 μg/m³ (Zone 2, station 4; rainy season) to 1620.54 μg/m³ (Zone 4, core area; winter season) during the period of study. Significant seasonal variations were observed for the SPM, SO_2, NO_x and CO. Although air quality measurements for some of air pollutants across the country have been observed below the national air quality standards, these pollutants played an important role in a number of air pollution issues. These compounds have contributed to the formation of ozone and particles, as well as, the deposition of acids and nutrients and visibility impairment.

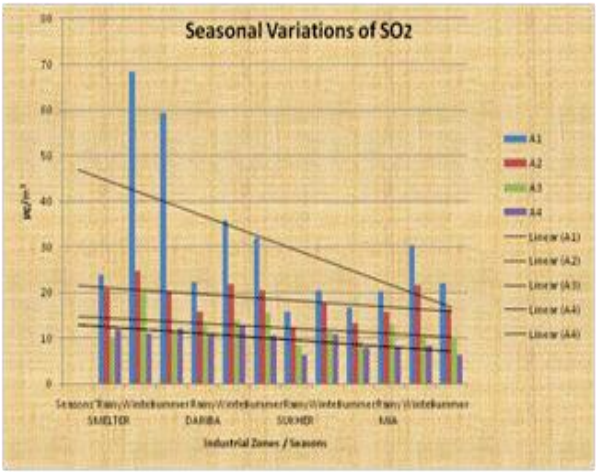
TABLE 1 MONTHLY WEATHER DATA OF STUDIED SITES

	Temperature		Humidity (%)		
Months	**Max**	**Min**	**Max**	**Min**	**km/ha**
Jan	25.3	4.9	88.6	30.9	3.3
Feb	31.5	9.3	83.3	24.4	2.2
Mar	30.9	11.9	77.8	33.5	3.3
Apr	36.1	17.4	50.9	18.4	4.1
May	39.2	25.4	54.0	26.3	6.7
Jun	37.8	26.2	61.2	37.2	7.2
Jul	30.2	24.5	85.8	71.7	6.7
Aug	28.2	22.9	89.4	78.2	5.5
Sep	31.1	21.6	89.0	61.3	3.9
Oct	32.2	15.8	86.1	36.0	2.0
Nov	28.9	10.3	89.3	31.6	1.5
Dec	25.7	7.5	90.7	40.7	2.0

TABLE 2 MONTHLY WEATHER DATA OF STUDIED SITES

	Wind		Sunshine	Rain	Weather
Months	**Directions**		**Hrs.**	**(mm)**	
Jan	0.0	16.9	0	0.0	30.2
Feb	0.5	16.4	0	00.0	2.6
Mar	1.9	20.1	5.7	00.0	2.9
Apr	12.5	21.9	0	33.6	16.8
May	20.5	22.8	0	4.8	2.4
Jun	17.9	20.7	119.6	74.8	97.2
Jul	15.0	22.2	203.6	256.1	229.9
Aug	20.8	23.2	593.8	152.8	373.3
Sep	15.9	24.0	655.4	363.1	509.3
Oct	1.0	16.4	0	00.0	0.0
Nov	1.1	13.1	0	00.0	0.0
Dec	0.0	10.6	0	00.0	0.0





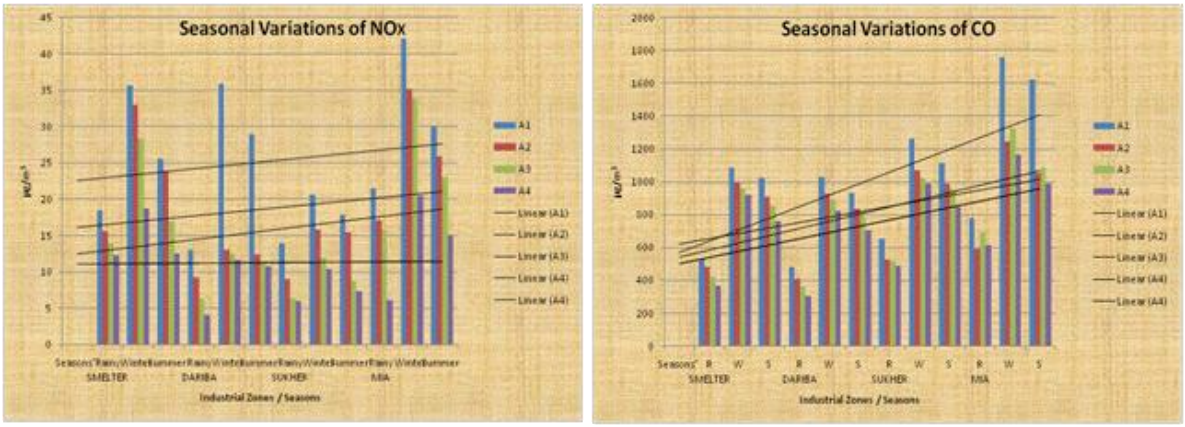


FIG. 1 STATUS OF SEASONAL VARIATION OF ATMOSPHERIC AIR POLLUTION IN STUDIED SITES OF UDAIPUR DIVISION, RAJASTHAN, INDIA

Discussion

Major part of polluted atmosphere contains fine pieces of fibrous material, inorganic compounds such as silica, malodorous sulphur compounds including SO_2 and NO_x. Out of the major air pollutants released from various industrial operations, SO_2 is one of the pollutant of concern. In India, the annual average SO_2 concentration ranges from 10-120 $\mu g/m^3$ (Agarwal, 2000). In addition to exerting a harmful effect on the human being and his assets, SO_2 causes damage to vegetation. It can be transported to longer distance and have a negative impact on biotic and abiotic environment (Cicek et al., 2001). Some of the plants species has been identified that have an ability to absorb, detoxify and tolerate high level of pollution (Nivane et al., 2001). Dust concentration affects relative water content (RWC) of leaves (Ramakrishnan and Somasekhar, 2003). Banerjee et al. (2003) found that fly ash severely affected chemical and bio-chemical composition of the leaves. Reddy and Ruj (2003) assessed ambient air quality in some areas of West Bengal and parallel studies were made by Shrivastava and Ojha (2003)in Jodhpur, Rajasthan. Bhargava et al. (2003) determined effect of automobile exhausts on total N,P and heavy metal content of roadside sugarcane in U.P.(India). Gokhale. And Patil (2004) studied size distribution of aerosols (PM_{10}) and lead (Pb) near traffic intersections in Mumbai (India). Kannan and Kapoor (2004) studied relationship of SO_2 and its particulate converts in the urban ambient air. Gadgil. and Jadhav (2004) studied street-level concentrations of SPM, NO_2 and SO_2 in Pune city. Lone et al. (2005) studied dust pollution caused by vehicular traffic in Aligarh city. Wherever air current passes through their dense formation, action like sieves takes place separating SPM in air by offering physical obstruction with considerable mechanical advantage (Chatsons Doley, 2006). Air pollution tolerance index is an important parameter which determines capability of plants to endure air pollution and plants having higher index value can be used as sinks. Thus, the plants can be used as both bio-monitors and bio-mitigators in the urban environment to analyze its quality and to attenuate the level of pollution in city under investigation. It may be therefore concluded that plants species which grow along the road normally (being also economically important), act as absorbent of various pollutants; dust and other particulate matter and their presence help us to minimize air pollution in any particular area. Presence of trees having dense cover and canopy around is better and their analysis may provide us an idea about nature of pollutant in any particular area. This is specially required that in urban as well as industrial areas, more and more plants species that are helpful in maintaining higher moisture level in micro-climate are planted, which ultimately makes suitable conditions for a clean and healthy atmosphere and promote better rains, which becomes prime requirement for any healthy human society. Bamniya et al. (2012 a, b; Kapoor et al. 2012, 2013) stressed on increasing realization that simultaneous to the planting of an industrial complex a parallel tree plantation programme should be launched, so that when the industry starts production and releases the emissions in the air, the green vegetational-belt present around it is ready to act as a vast and efficient sink for the pollutants. Selection of species to be grown around an industrial complex is a tedious job and requires a fundamental understanding about the plants, their behaviour towards pollutants and also their responses in the polluted atmosphere.

Conclusions

In our investigations, it has been found that levels of

air pollution were minimum in residential areas, higher on roads affected by vehicular traffic and the highest in industrial area of the parameters studied SO_2, NO_x, SPM, CO. Hence the only alternative which is feasible and helps us to combat air pollution from all sources is to plant more and more trees and vegetation, which will maintain higher amount of relative moisture into the atmosphere thereby more rainfall during monsoon season in addition to protective role. Also, this will check amount of dust into the atmosphere, wind speed and keep atmosphere rich in O_2 and deficient in CO_2 and other pollutants.

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REFERENCES

Aftab, A., and Saki A. "Study of sulfur accumulation on plant foliage due to coal smoke pollution". Geobios, 30(2003): 284-285.

Agrawal, M., and Agrawal SB. "Phytomonitoring of air pollution around a thermal power plant". Atmosphere Environment, 23(1990):763-769.

Agrawal, M. "Researches on air pollution effects on vegetation in India. A review", The Botanica 50(2000): 75-83.

Aihara, K. Evaluation of air pollution using indictor plants. Kankya Gijustu, 25(1996): 674-680.

Bamniya, BR, Kapoor, CS, and Kapoor K. "Searching for efficient sink for air pollutants- studies on *Mangifera indica* L." Clean Technologies and Environmental Policy, 14(2012a):107–114.

Bamniya, BR., Kapoor, CS., Kapoor, K., and Kapasya V.. "Harmful effects of air pollution on physiological activities of *Pongamia pinnata* (L.) Pierre". Clean Technologies and Environmental Policy, 14 (2012b):115–124.

Banerjee, SK, and Sett R. "Fly ash: Characteristics, environmental impact and possible utilization". In 'Pollution Management' (Eds. P.C. Trivedi and Sampat Nehra), Poin Publi Jaipur, India. Pp (2007):51-76.

Banerjee, S,. Singh, AK., and Banerjee, SK. "Impact of fly ash on foliar chemical and biochemical composition of naturally occurring ground flora and its possible utilization for growing tree crops". Indian Forester, 8 (2003):964-977.

Banerjee, SK., Kashyap, MK., and Manjhi RB. "Characteristics and environmental impact of fly ash". TFRI Publication No. 17, Tropical Forest Research Institute, Jabalpur. (1998) 54.

Beckett, KP., Free–Smith PH., and Taylor G. "Urban woodland: their role in reducing the effect of particulate pollution". Environmental Pollution, 99(1988): 347-306.

Bhargava, AK., Gupta, R., Bhargava, S., and Paridhi. "Effect of automobile exhausts on total N, P and total heavy metal of road side sugarcane at district Saharanpur, U.P". Advances in Plant Sciences, 16(2003) :557-560.

Burchett, M., Rachid, M., and Jane T. Air Pollution and Plant Biotechnology, 16(2002): 61-91.

Chatson, K., and Doley D. "Mineral particulates and vegetation: Effect of coal dust, overburden and fly ash on light interception and leaf temperature". Clean Air and Environmental Quality, 40(2006): 40-44.

Cicek, A., Koparal, AS., Catak, S., and Uger S. "Study of some heavy metals and nutritional elements in samples from soil and tree leaves growing in the seyitomer thermal power plants in Kutahya". In 'Air Quality Management at Urban Regional and Global Scale', Bulletin Turkey (eds. Topcu S., Yardim M.F. and Incecik, S.), (2001):157-162.

Dwivedi, AK., and Tripathi BD. "Pollution tolerance and distribution pattern of plants in surrounding areas of coal-fired industries". Journal of Environmental Biology, 28(2007):257-263 .

Gadgil, AS., and Jadhav RS. "Street-level concentrations of suspended particulate matter (SPM), nitrogen dioxide (NO_2) and sulphur dioxide (SO_2) in Pune city". Journal of Environmental Science and Engineering 46(2004):143-150.

Gokhale, S., and Patil RS. "Size distribution of aerosols (PM_{10}) and lead (Pb) near traffic intersections in Mumbai (India)". Environmental Monitoring and Assessment, 95:(2004) 313-324.

Jacobs, M B., and Hochheiser S. "Continuous sampling and

ultramicro determination of nitrogen dioxide in air". Analytical Chemistry, 30(1958): 426–428.

Joshi, SD et al., "A few measurements on ambient air pollutants of Udaipur city". Indian Journal of Environmental Health 33(1991): 31-39.

Kannan, GK., and Kapoor JC. "Relationship of sulphur dioxide and its particulate converts in the urban ambient air". Indian Journal of Air Pollution Control, 4:(2004)1-8.

Kantarci, MD. "The effects air pollution on forests Biga Peninsula". Journal of Environmental Protection & Ecology 2(2001):806-817.

Kapoor, CS, Bamniya, BR, and Kapoor K. "Efficient control of air pollution through plants, a cost-effective alternative: studies on *Dalbergia sissoo* Roxb". Environmental Monitoring and Assessment, 185((2013):7565–7580

Kapoor, CS, Bamniya, BR, and Kapoor K. "Natural and effective control of air pollution through plants- studies on a tree species: *Holoptelea integrifolia* L". Mitigation and Adaptation Strategies for Global Change, 17(2012):793-803.

Kim, KH, Lee, JH, Jang MS. "Metals in air-borne particulate matters in the Taejon industrial complex area on Korea". Environmental Pollution, 118(2000):41–51.

Li, Zhenzhan. "Estimation of sulphur bearing content of the trees and contamination situation on Zhonghunan road, Syenyang city". Liaoning Daxue Xue Bao, Zheran ke xue Ban. 28(2001):170-173.

Lone, PM et al., "Study of dust pollution caused by traffic in Aligarh city". Indian Journal of Environmental Health, 4(2005):33-36.

Mahendra, SP, Krishnamurthy. "Vehicular air pollution at some intersections in Bangalore city. A case study". Nature and Environmental Pollution Technology, 2 (2003) :187-191.

Mehta, UK. "Study on ambient air quality around SIEL chemical complex near Rajpura, (District-Patiala) Punjab". Environmental Pollution Control Journal, 5 (2002):19-25.

Nivane, SY et al., "Foliar biochemical features of plants as indicators of air pollution". Bulletin of Environmental Contamination and Toxicology, 67(2001):133-140.

Pattnaik, S., and Pattnaik M. Combating air pollution in India. Employment News, (2000) Volm, XXV.

Ramakrishnaiah, H., and Somasekhar RK "Higher plants as bio-monitors of automobile pollution". Ecology & Environmental Conservation, 9(2003):337-343.

Reddy, GS., and Ruj B. "Ambient air quality status in Raniganj-Asansol area, India". Environmental Monitoring and Assessment, 89(2003):153-163.

Rehme, KA., Smith, CF., and Fitizsimmons MI. "Investigation for use in the determination of ambient particulate matter". Research Triangle Park NC (1984) 048.

Shrivastava, KL, Ojha S. "Commercial and mixed zone's of Jodhpur city- a comprehensive survey of ambient air". Oikoassay, 16(2003):23-28.

West, PW., and Gaeke GC. "Fixation of sulphur dioxide as sufitomercurate III and subsequent colorimetric determination". Analytical Chemistry, 28(1956):1816-1819.

Biographical Notes

Dr. Chandra Shekhar Kapoor has been trained as an environmentalist basically. He passed M.Sc. (Environmental Science) with first class from Mohanlal Sukhadia University (MLSU), Udaipur, Rajasthan, India. His doctoral research at Mohanlal Sukhadia University, was on air pollution & its impact on plants in urban, industrial and forest environment. His area of specialization is Environment Engineering & Biotechnology, studies about various kinds of pollutants, water characteristics and remedial measures.

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Dr. Kapoor finds place as member of the editorial board of **11** international journals, viz., **Journal of Biochemistry Research, *Dr Dallas Texas, USA*, Peak Journal of Biotechnology, *Dr Dallas Texas , USA,* I**nternational Research Journal of Musicology and Drama, Nigeria, Prudence Journal of Environmental Science Research, Nigeria, etc. Acted as **Referee** of **31 International journals** like Mitigation and Adaptation of Strategies for Global Change, **Springer-Verlag, *Netherlands***; International Journal of Anatomy and Physiology, ***Brooklyn, New York***; Environmental Engineering and Management Journal, ***Romania***; African Journal of Environmental Sciences & Technology, African Journal of Mining & Geology, Educational Research, Nigeria and Journal of Environmental Science and Water Resources, **Victoria Island, Lagos,** etc.

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